Chapter 15: Making our resources 1

Knowledge organiser

Corrosion

Corrosion is when a material reacts with substances in the environment and eventually wears away. Corrosion can be prevented in in two ways:

- physical barriers
- sacrificial protection

Rusting is an example of corrosion. It is caused by iron reacting with oxygen *and* water from the environment.

Physical barriers

The material is covered with a physical barrier like grease, paint, or a thin layer of another metal by a process called electroplating.

Aluminium reacts with oxygen to make a very thin layer of aluminium oxide around the metal that acts as a physical barrier. This layer then protects the rest of the metal from corrosion.

Sacrificial protection

A more reactive substance is placed on the material. The more reactive substance will react with the environment, and not the main material.

For example, iron is **galvanised** with zinc. The zinc then reacts with the oxygen and water in place of the iron.

Alloys

Alloys allow us to tailor the properties of metals to specific uses.

Alloy	Composition	Properties	Use
bronze	copper and tin	resistant to corrosion	statues, decorative items, ship propellers
brass	copper and zinc	very hard but workable	door fittings, taps, musical instruments
gold alloys	mostly gold with copper, silver and zinc added	attractive, corrosion resistant, hardness depends on carat	jewellery the proportion of gold is measured in carats. 24 carat gold contains 100% gold, 18 carat gold contains 75% gold
high carbon steel	iron with 1–2% carbon	strong but brittle	cutting tools, metal presses
low carbon steel	iron with <1% carbon	soft, easy to shape	extensive use in manufacture of cars, machinery, ships, containers, structural steel
stainless steel	iron with chromium and nickel	resistant to corrosion, hard	cutlery, plumbing
aluminium alloys	over 300 alloys available	low density, properties depend on composition	aircraft, military uses

Ceramics

Ceramics are materials with versatile properties that can have many different uses.

Ceramic	Manufacture	Properties	Uses
soda-lime glass	heat a mixture of sand, sodium carbonate, limestone	transparent, brittle	everyday glass objects
borosilicate glass	heat sand and boron trioxide	higher melting point than soda-lime glass	oven glassware, laboratory glassware
clay ceramics (pottery + bricks)	shape wet clay then heat in a furnace	hard, brittle, easy to shape before manufacture, resistant to corrosion	crockery, construction, plumbing fixtures

Polymers

The properties of polymers depend on

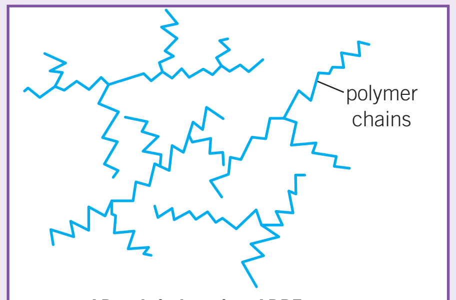
- the monomers that make them up
- the conditions under which they are made.

For example, **low density poly(ethene)** and **high density poly(ethene)** are both made from ethene monomers but have very different properties due to the way that the polymer chains line up in the material.

Low density poly(ethene)

LDPE is formed when the addition polymerisation reaction of ethene is carried out under high pressure and in the presence of a small amount of oxygen.

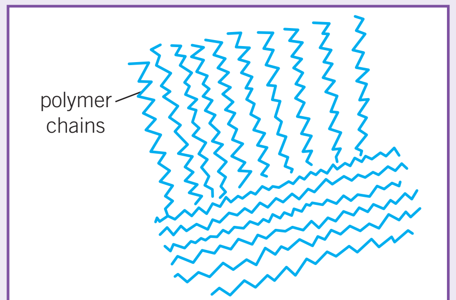
The branched polymer chains cannot pack together, so causing the low density of the polymer.



LD poly(ethene) or LDPE

High density poly(ethene)

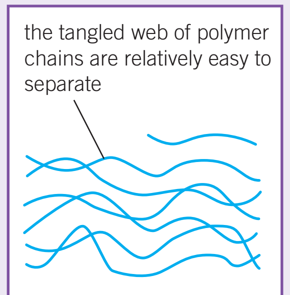
HDPE is formed when the addition polymerisation reaction of ethene is carried out using a catalyst at 50 °C. The polymer chains are straight and can pack tightly together, so causing the high density of the polymer.



HD poly(ethene) or HDPE

Thermosoftening polymers

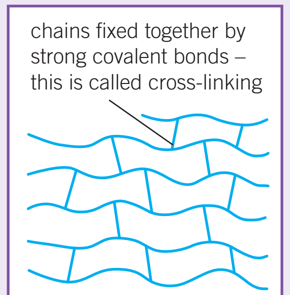
Thermosoftening polymers do not have links between the different chains, and soften when they are heated.



thermosoftening polymer

Thermosetting polymers

Thermosetting polymers have strong links between the different chains, and do not melt when they are heated.



thermosetting polymer

Composites

Composites are made from a main material (called a **matrix**) with fragments or fibres of other materials (called **reinforcements**) added into them. This means the material's properties can be made more useful.

Plywood and reinforced concrete are examples of composites.

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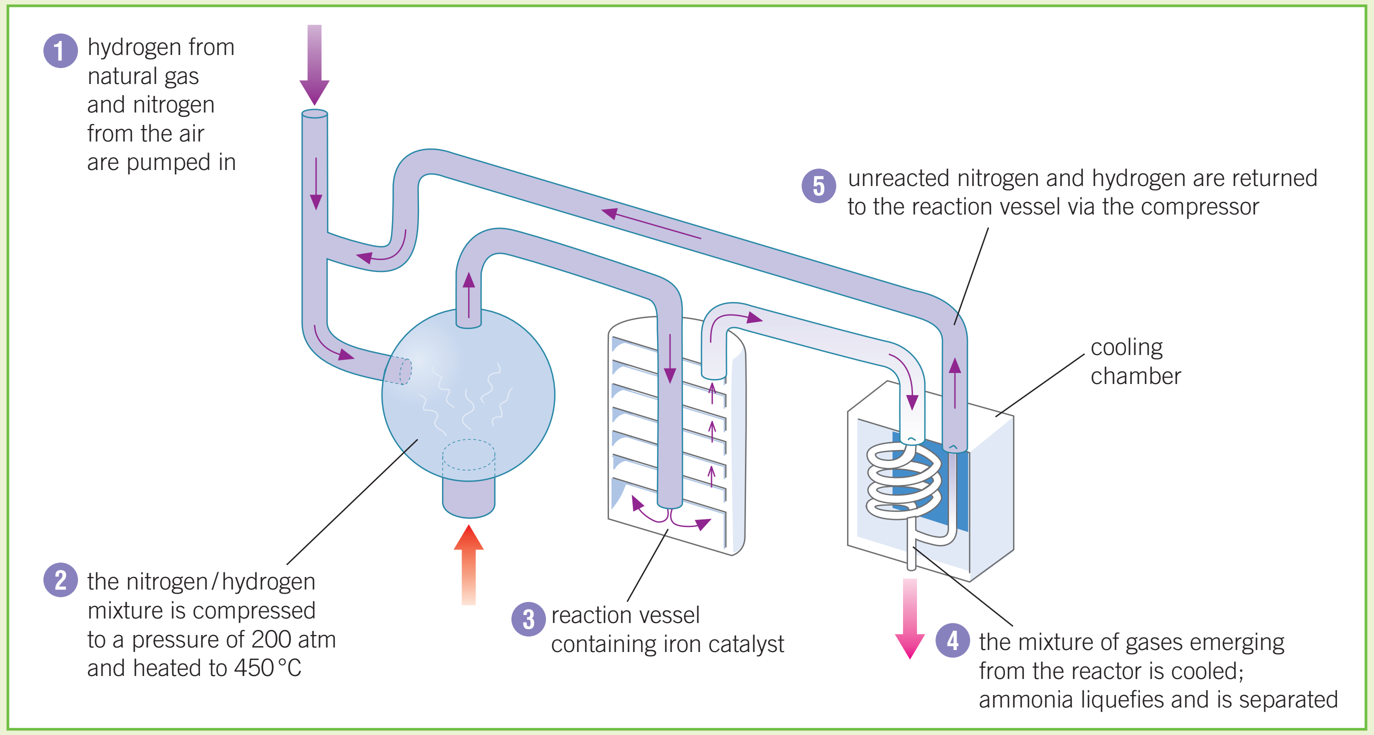
Knowledge organiser

The Haber process

Fertilisers are important chemicals used to improve the growth of crop plants. Ammonia is a vital component of many fertilisers. It is produced in the **Haber process**:

- nitrogen + hydrogen ⇌ ammonia
- $N_2(g) + 2H_2(g) \rightleftharpoons 2NH_3(g)$

It is a reversible reaction, so the conditions affect the yield.



Conditions

Compromise

The conditions used for the Haber process are a *compromise* to balance yield, cost, and rate.

- an iron catalyst
- temperatures of about 450 °C
- pressure of about 200 atmospheres

Temperature

The forward reaction is exothermic. Therefore, lowering the temperature would increase the yield of ammonia, but would also decrease the rate of reaction.

Pressure

There are fewer gas molecules on the product side, so increasing the pressure would increase the yield and the rate of reaction. However, it is very expensive to increase the pressure.

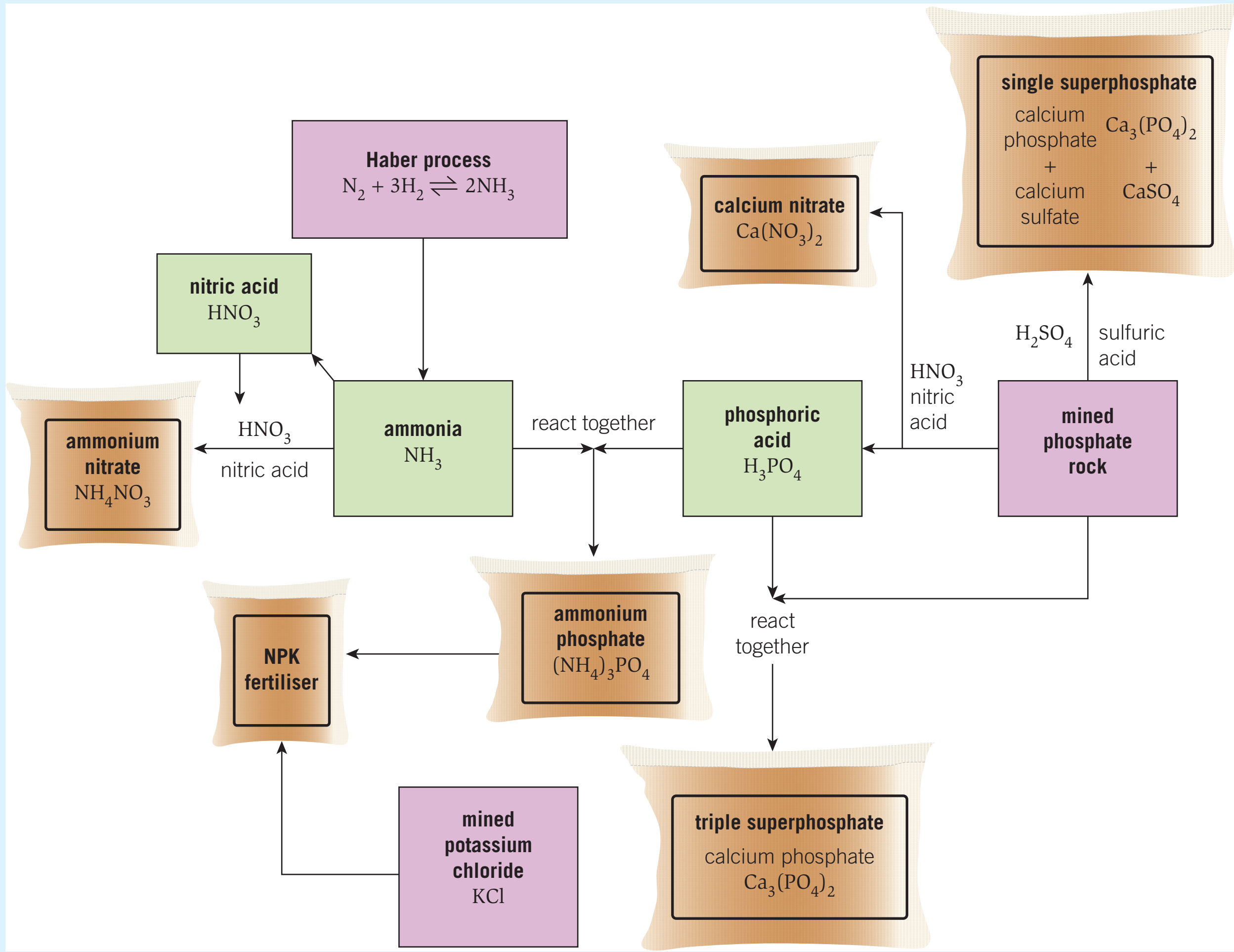
Catalyst

Iron is an effective catalyst for the Haber process. It does not increase the yield, but does increase the rate.

Fertilisers

Fertilisers are produced industrially to increase the amount of food obtained from crops. Compounds containing nitrogen, phosphorous, and potassium are used, and fertilisers with all three in them are called **NPK fertilisers**.

NPK fertilisers are formulations. Some of the substances that go into NPK fertilisers can be mined straight from the ground (like potassium chloride or potassium sulfate). Others, like phosphate rock, need to be processed first. Phosphate rock can react with different acids to make different products, which can either be used as fertilisers on their own or added to an NPK fertiliser.



Laboratory vs. industry

The compounds found in fertilisers can be produced in the laboratory as well as industrially:

	laboratory	industrial
Quantities produced	small	large
Process	batch (do it once)	continuous (can keep doing it)
Apparatus	glass	stainless steel
Speed	slow	fast

Key terms

Make sure you can write a definition for these key terms.

alloy ceramic composite corrosion galvanise Haber process matrix NPK fertiliser reinforce rusting thermosetting thermosoftening